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AFOSR-TR- 81 - 0350

FINAL REPORT

to

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
Directorate of Chemical Sciences

(Grant No. [REDACTED])

AFOSR-80-0206

on

SCIENTIFIC RESEARCH CONFERENCE
entitled

"FRONTIERS OF GLASS SCIENCE"
July 16 - 18, 1980, Los Angeles, California

Principal Investigator: J. D. Mackenzie

Materials Science and Engineering Department
School of Engineering and Applied Science
University of California
Los Angeles, California 90024

January, 1981

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APPROVED
DATE

ABSTRACT

An international scientific conference entitled, "Frontiers of Glass Science" was successfully held at the University of California, Los Angeles, from July 16 to 18, 1980, under AFOSR sponsorship. The conference was attended by over 160 people from 14 countries. Sixty papers were presented in five separate sessions. A proceedings of the conference numbering 665 pages was published in December, 1980. J. D. Mackenzie and J. R. Varner of UCLA who co-chaired the meeting were also co-editors of the Proceedings.

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFSC)
NOTICE OF TRANSMITTAL TO DDC

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A. D. BLOOM
Technical Information Officer

I. INTRODUCTION

In the past five years, glasses have become more important as materials of engineering. Some examples are the use of high purity glass fibers in wave-guides, new glass systems for various components of high power lasers, chemically strengthened glass for transparent enclosures and infrared transmitting glasses. A great deal of the research is being done abroad. Most of the research results are of importance to the U.S. Air Force and to U.S. scientists. It was considered highly desirable to organize a scientific conference at which leading foreign scientists who are working on some selected areas of glass science of particular importance be given an opportunity to discuss their most recent research on glass science but it will be important to U.S. glass scientists as well as Air Force personnel.

The 12th International Glass Congress was held in Albuquerque, New Mexico from July 6 to 12, 1980. This was a large conference at which hundreds of papers were given by many foreign and U.S. participants. The topics covered ranged from the physics of a glass to glass manufacturing problems faced by industry. Presentations were in English, French and German with simultaneous translations. This did not permit effective discussions. Participants also had to submit a finished manuscript prior to December 31, 1979. Thus it was not a conference at which a selected small group of scientists could discuss their most recent research efficiently. The International Glass Congress, however, did provide the opportunity for some foreign scientists to visit the U.S.A.

It was the opinion of the present principal investigator (J.D. Mackenzie) that if a separate smaller conference on selected topics of glass science were to be organized after the International Glass Congress at Albuquerque, it would attract: (a) many foreign scientists who were already attending the Glass Congress, (b) some prominent foreign scientists who might have considered the Glass Congress alone as of insufficient importance to come to the U.S.A. and (c) many leading U.S. scientists especially if the proposed conference were to be held at Los Angeles, California, after the large Congress at Albuquerque, New Mexico.

All those scientific colleagues consulted by J. D. Mackenzie shared his feelings on the desirability and timeliness of a glass conference at Los Angeles after the Albuquerque meeting. Faculty of the Materials Science and Engineering Department at the University of California, Los Angeles (UCLA) had agreed unanimously to sponsor and support such a glass conference to be held on the UCLA campus from July 16 to 18, 1980. Subsequently, a local organizing committee was formed, together with an international advisory committee. The committees were:

LOCAL ORGANIZING COMMITTEE

J. D. Mackenzie (Chairman), Professor, Materials Science and Engineering Dept.

O. L. Anderson, Professor, Geophysics and Planetary Physics Dept.

R. Braunstein, Professor, Physics Dept.

W. J. Knapp, Professor, Materials Science and Engineering Dept.

J. R. Varner, Assistant Professor, Materials Science and Engineering Dept.

C. N. J. Wagner, Professor, Materials Science and Engineering Dept.

INTERNATIONAL ADVISORY COMMITTEE

Professor David Adler, M.I.T., Cambridge, Mass.

Professor G. H. Frischat, Clausthal University, West Germany

Dr. J. J. Gilman, Allied Chemical Corp., Morristown, N.Y.

Professor P. W. McMillan, Warwick University, United Kingdom

Dr. R. D. Maurer, Corning Glass Works, Corning, N.Y.

Professor K. Takahashi, Okayama University, Japan

Dr. D. R. Ulrich, AFOSR, Washington, D.C.

Dr. M. J. Weber, Lawrence Livermore Laboratory, Livermore, CA.

Professor J. Zarzycki, Montpellier University, France

The meeting was successfully held on the campus of the University of California, Los Angeles, from July 16 to 18, 1981, under joint sponsorships of the Directorate of Chemical Sciences, AFOSR and the Materials Science and Engineering Department of UCLA. Summary of the highlights of the meeting is provided in this report.

II. ATTENDANCE

Attendance was opened to all those who had pre-registered. The total number of attendees amounted to 160 persons from 14 countries.

III. PROGRAM OF THE MEETING

The meeting commenced on Wednesday morning, July 16 and ended on Friday afternoon, July 18. A total of 60 papers, divided into five sessions, were presented. Eleven papers were given by "invited lecturers." They were:

P. Flory, Stanford University, CA.

D. Adler, M.I.T., MA.

R. J. Arango, PPG Industries, Inc., PA.

H. Franz, PPG Industries, Inc., PA.

R. E. Loehman, SRI International, CA.

R. D. Maurer, Corning Glass Works, NY.

K. Nassau, Bell Labs, NY.

S. Sakka, Mie University, Japan

D. R. Uhlmann, M.I.T., MA.

C. N. J. Wagner, UCLA, CA.

M. J. Weber, Lawrence Livermore Laboratory, CA.

The co-chairmen of the meeting were J. D. Mackenzie and J. R. Varner, both of UCLA. The session chairmen were:

WEDNESDAY, 16 JULY

SESSION I. A. STRUCTURE

J. Zarzycki
D. Griscom

SESSION I. B. SPECIAL LECTURES

D. Ulrich
S. Ohlberg

SESSION I. C. STRUCTURE

H. Scholze
H. Kawazoe

THURSDAY, 17 JULY

SESSION II. OPTICAL & ELECTRICAL PROPERTIES

S. Ovshinsky
J. Isard

SESSION III. AMORPHOUS SEMICONDUCTORS & ELECTRICAL PROPERTIES

R. Weeks
A. Bishay

FRIDAY, 18 JULY

SESSION IV. LESS COMMON GLASSES

G. Frischat
C. Goodman

SESSION V. GLASS SURFACES & CHEMICAL DURABILITY

J. Varner
K. Takahashi

A copy of the program is given in Appendix I.

IV. PROCEEDINGS

All but a few manuscripts were received by J. D. Mackenzie and J. R. Varner, the manuscripts were sent to the North-Holland Publishing Company for printing. The Proceedings were printed in December, 1980, and distributed to all registrants of the meeting. Drs. Donald Ball and Donald Ulrich of the AFOSR were both sent a copy of the Proceedings. The front cover, preface and acknowledgements, table of contents of the Proceedings which numbered 665 pages are shown in Appendix II.

V. CONCLUSIONS

Based on the number of attendees, the quality of the papers, the vigor of the discussions, the rapidity of the publication of the Proceedings and comments of the attendees, the meeting can be considered a great success. Without the support of AFOSR, the meeting would have been impossible. The principal investigator and his committee members at UCLA are grateful to Drs. Donald Ball and Donald Ulrich and to AFOSR for the funding of such an important and timely international conference.

FRONTIERS OF GLASS SCIENCE

AN INTERNATIONAL CONFERENCE

UNIVERSITY OF CALIFORNIA
LOS ANGELES, CALIFORNIA

JULY 16-18, 1980

FINAL PROGRAM

2160E Dickson, UCLA CAMPUS

WEDNESDAY, 16 July

7:30-12:00 Registration

8:15- 8:30 Welcoming remarks: Dean R. R. O'Neill and J. D. Mackenzie

SESSION I. A. Structure

8:30- 9:00 C. N. J. Wagner (INVITED LECTURE) "Diffraction Analysis of Metallic, Semiconducting, and Inorganic Glasses".

9:00- 9:15 F. L. Galeener, J. C. Mikkelsen, Jr., A.C. Wright, R. N. Sinclair, J. A. E. Desa, "Raman and Inelastic Neutron Scattering by Vitreous ZnCl_2 ".

9:15- 9:30 N. Takusagawa, "Infrared Absorption Spectra and Structure of Fluorine-containing Alkali Silicate Glasses".

9:30- 9:45 D. J. Lam, B. W. Veal and A. P. Paulikas, "X-ray Photoemission Spectroscopy Studies of Soda Aluminosilicate Glasses".

9:45-10:00 P. Bruckner, H. -U. Chun, H. Goretzki, M. Sammet, "XPS Measurements and Structural Aspects of Silicate and Phosphate Glasses".

10:00-10:30 BREAK

- 10:30-10:45 D. Beeman, R. Lynds, and M. R. Anderson, "Structural and Vibrational Properties of a Model of Vitreous As_2O_3 ".
- 10:45-11:00 A. C. Wright, G. A. N. Connell and J. W. Allen, "Amorphography and the Modelling of Amorphous Solid Structures by Geometric Transformations".
- 11:00-11:15 G. H. Dohler, R. Dandoloff and H. Bilz, "A Topological-Dynamics Model of Amorphicity".
- 11:30-11:45 D. F. R. Mildner and A. C. Wright, "Elastic Diffraction from Amorphous Materials Using a Pulsed Neutron Source".
- 11:45-12:00 R. N. Sinclair, G. Etherington, P. A. V. Johnson and A. C. Wright, "Neutron Diffraction Studies of Amorphous Solids".
- 12:00- 1:30 LUNCH

SESSION I. B. SPECIAL LECTURES

- 1:30- 2:45 P. Flory (INVITED LECTURE)
- 2:45- 3:15 D. Uhlmann (INVITED LECTURE), "Polymer Glasses & Oxide Glasses".
- 3:15- 3:45 BREAK

SESSION I: C. STRUCTURE

- 3:45- 4:00 P. Taylor and Derrek Owen, "Liquid Immiscibility in Complex Borosilicate Glasses".
- 4:00- 4:15 Y. Bando, S. Iijima, Y. Kawamoto and M. Tomozawa, "Application of STEM to Element Analysis in Glass".
- 4:15- 4:30 K. Takahashi, T. Yoshio, K. Oda and F. Kanamuru, "Crystallization of Amorphous $\text{BaO-Fe}_2\text{O}_3$ Prepared by the Method Without Melting".
- 4:30- 4:45 J. F. Shackelford, "The Potential of Structural Analysis from Gas Transport Studies".
- 4:45- 5:00 H. D. Schreiber, "Properties of Redox Ions in Glasses An Interdisciplinary Perspective".

5:00- 5:15 S. M. Rekhson, "Linear and Non-Linear Viscoelasticity of Glass".
 6:30- 7:30 NO HOST COCKTAILS
 7:30 CONFERENCE BANQUET

THURSDAY 17 JULY

SESSION II. OPTICAL AND ELECTRICAL PROPERTIES

8:30- 9:00 M. J. Weber (INVITED LECTURE), "Glasses for Laser Applications".
 9:00- 9:30 R. D. Maurer (INVITED LECTURE) "Glass Research for Optical Waveguides".
 9:30-10:00 R. J. Araujo (INVITED LECTURE) "A Statistical Mechanical Model for Boron Coordination in Alkali Aluminoborosilicate Glasses".
 10:00-10:30 BREAK
 10:30-10:45 S. Morimoto and M. Mishima, "Effect of Composition on Properties of Silver Halide Photochromic Glass".
 10:45-11:00 J. Gannon, "Optical Fibre Materials for Operating Wavelengths Longer than 2 Microns".
 11:00-11:15 F. T. Stone and B. K. Turiyal, "Loss Reduction in Optical Fibers".
 11:15-11:30 J. A. Wysocki, S. N. Alam, J. R. Varner, "Low Cycle Fatigue Behavior of Metal Coated Silica Fibers".
 11:30-11:45 Y. Asahara and T. Izumitani, "Properties of Gradient Index Antireflection Layer of the Phase Separable Glass".
 11:45-12:00 H. Kawazoe, "Coordination Number and Chemical Shift of $N_{1,2}$ Emission of Mg^{2+} in Oxide Glasses".
 12:00- 1:30 LUNCH

- 1:30- 1:45 D. L. Griscom, "Ferromagnetic Resonance of Fine Grained Precipitates in Glass".
- 1:45- 2:00 D. P. Button, R. P. Tandon, H. L. Tuller and P. R. Uhlmann, "Transport Model for Fast Li^+ Ion Conduction in Chloro-Borate Glasses".
- 2:00- 2:15 R. A. Weeks, "The Effect of OH on UV Optical Absorption of Reduced GeO_2 Glass"

SESSION III. AMORPHOUS SEMICONDUCTORS & ELECTRONIC PROPERTIES

- 2:15- 2:45 D. Adler (INVITED LECTURE), "Electronic Structure of Amorphous Semiconductors".
- 2:45- 3:00 S. Ovshinsky, "The Chemistry of Glassy Materials and Their Relevance to Energy Conversion".
- 3:00- 3:15 K. S. Liang, S. P. Cramer, D. C. Johnston, A. J. Jacobson, J. P. deNeufville, and R. R. Chianelli, "Amorphous MoS_3 and WS_3 ".
- 3:15- 3:45 BREAK
- 3:45- 4:00 C. H. Chung and J. D. Mackenzie, "Electrical Properties of Binary Semiconducting Oxide Glasses Containing 55 mole% V_2O_5 ".
- 4:00- 4:15 J. O. Isard, "The Application of Polaron Theory to Oxide Glasses".
- 4:15- 4:30 J. Robertson, "Electronic Structure of Model Lead Silicate Glasses".
- 4:30- 4:45 T. Szorenyi, "Correlation between Structure and Properties in Vanadium Phosphate Glasses and Amorphous V_2O_{5-x} ($0 < x < 1$) Films".
- 7:00 BUSES LEAVE FOR HOLLYWOOD BOWL FROM UCLA

FRIDAY, 18 JULYSESSION IV: LESS COMMON GLASSES

- 8:00- 8:30 S. Sakka (INVITED LECTURE)
- 8:30- 8:50 K. Nassau (INVITED LECTURE) "Rapidly Quenched Glasses".
- 8:50- 9:15 R. E. Loehman (INVITED LECTURE) "Oxynitride Glasses".
- 9:15- 9:30 A. Kinoshita, "Characterization of Glass Transition in α -As₂Se₃ by Heat of Vaporization".
- 9:30- 9:45 C. M. Baldwin and J. D. Mackenzie, "Ionic Transport in the BeF₂-CsF Glass System".
- 9:45-10:00 T. Minami, K. Imazawa and M. Tanaka, "Formation Region and Characterization of Superionic Conducting Glasses in the Systems AgI-Ag₂O-M_xO_y".
- 10:00-10:30 BREAK
- 10:30-10:45 S. P. Mukherjee, "Sol-Gel Processes in Glass Science and Technology".
- 10:45-11:00 R. Jabra, J. Phalippou and J. Zarzycki, "Synthesis of Binary Glass-Forming Oxide Glasses by Hot-Pressing of Gels".
- 11:00-11:15 I. Vincze and F. van der Woude, "Correlation Between Amorphous and Metastable Crystalline Alloys".
- 11:15-11:30 J. W. Allen, G. A. N. Connell and A. C. Wright, "Hybridization, Short Range Order, and Entropy in Metallic Glass Formation".
- 11:30-11:45 A. Bishay, M. Farag, M. Nassrallah, S. El Nahawi, and S. A. Saleh, "Some Properties and Structure of Iron-Contained Glasses and Glass-Metal Composites".
- 11:45- 1:15 LUNCH

SESSION V: GLASS SURFACES AND CHEMICAL DURABILITY

- 1:15- 1:45 H. Franz (INVITED LECTURE), "Durability and Corrosion of Silicate Glass Surfaces".
- 1:45- 2:00 Y. Oka and M. Tomozawa, "Inhibitor to Alkali Attack on Silica Glass".
- 2:00- 2:15 A. Makishima, H. Oohashi, M. Wakakuwa, K. Kotani, and T. Shimohira, "Alkaline Durabilities and Structure of Amorphous Aluminosilicates Containing ZrO_2 Prepared by the Chemical Polymerization of Metal Alkoxides".
- 2:15- 2:30 P. J. Melling and A. R. Allnatt, "Modelling of Corrosion and Leaching Reactions in Glass".
- 2:30- 2:45 H. J. Franek, G. H. Frischat, and H. Knodler, "Reactions Between Aqueous Solutions and Glass Surface".
- 2:45- 3:00 S. Adachi, E. Miyade, and T. Izumitani, "Chemical Durability of Optical Glasses".
- 3:00- 3:15 L. Rongved, C. R. Kurkjian, and F. T. Geyling, "Mechanical Tempering of Glass Fibers".
- 3:15- 3:45 BREAK
- 3:45- 4:00 L. Schaar, "Themes for Glass Research in the Field of Hollow Ware Production".
- 4:00- 4:15 V. V. Moiseev, "Ion Exchange and Constitution of Glass".
- 4:15- 4:30 M. Spitzer-Aronson, "A New Method for the Study of Flat Glasses Accurate Microstructure".
- 4:30- 4:45 S. K. Sharma, R. Simons, and J. F. Mammone, "Relationship Between Density, Refractive Index, and Structure of B_2O_3 Glasses at Low and High Pressures".
- 4:45- 5:00 Dr. Katzuki et al., "Laminated Plate Composed of Thin Glass and Plastic Sheets".

Appendix II

FRONTIERS OF GLASS SCIENCE

Proceedings of the
International Conference on Frontiers of Glass Science

University of California, Los Angeles, July 16 - 18, 1980

Edited by
J.D. Mackenzie and J.R. Varner



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PREFACE

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Service
A. B. G.
G. F. G.

PREFACE AND ACKNOWLEDGMENTS

In the past decade, glasses have become more important as materials of engineering. Some examples are the use of high purity glass fibers in waveguides, new glass systems for various components of high power lasers, infrared transmitting glasses and alkali-resistant glass fibers. An increasing amount of the research is being done outside the U.S.A. The objective of the present Conference was to bring together an outstanding international group of glass scientists to review some of the significant advances of the past decade and to speculate on future opportunities and needs for research. Thanks to the sponsorship of the Department of Materials Science and Engineering of the University of California, Los Angeles (UCLA), and to the financial support of the Directorate of Chemical Sciences, U.S. Air Force Scientific Research, the Conference was held on the campus of UCLA on July 16-18, 1980. Some 160 persons from 14 countries attended the Conference. Practically all the manuscripts of the 160 papers presented are published in this volume.

The success of the Conference and of the publication of this volume is dependent on many organizations and people. We wish to acknowledge the advice and support especially of the following persons:

International Advisory Committee

D. Adler, M.I.T., Cambridge, Mass. (USA)
G.H. Frisch, Clausthal University (West Germany)
J.J. Gilman, Allied Chemical Corp., Morristown, NY (USA)
P.W. McMillan, Warwick University (UK)
R.D. Maurer, Corning Glass Works, Corning, NY (USA)
K. Takahashi, Osaka University (Japan)
D.R. Uhlir, AFOSR, Washington, D.C. (USA)
M.J. Weber, Lawrence Livermore Laboratory, Livermore, CA (USA)
J. Zurek, Montpellier University (France)

UCLA Organizing Committee

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R. Braunstein, Physics Department
W.J. Knapp, Department of Materials Science and Engineering
J.R. Varner, Department of Materials Science and Engineering
C.N.J. Warner, Department of Materials Science and Engineering
J.D. Mackenzie (Chairman), Department of Materials Science and Engineering

Session Chairmen at the Conference

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G. Frisch, Clausthal University (West Germany)

C.M.E. Goodman, Standard Telecommunications Lab. Ltd. (England)
 D. Griscom, Naval Research Laboratory, Washington D.C. (USA)
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 H. Scholze, Fraunhofer-Institut für Silicatforschung, Wurtzburg (West Germany)
 K. Takahashi, Okayama University (Japan)
 D.R. Ulrich, AIOSR, Washington D.C. (USA)
 J.R. Varner, University of California, Los Angeles, CA (USA)
 R.A. Weeks, Oak Ridge National Laboratory, Oak Ridge, TN (USA)
 J. Zarzycki, Montpellier University (France)

Invited Lecturers

P. Flory, Stanford University, CA
 D. Adler, Massachusetts Institute of Technology, MA
 R.J. Araujo, Corning Glass Works, NY
 H. Frank, PPG Industries Inc., PA
 R.E. Lochman, SRI International, CA
 R.D. Maurer, Corning Glass Works, NY
 K. Nassau, Bell Labs, NY
 S. Sakka, Mie University, Japan
 D.R. Uhlmann, Massachusetts Institute of Technology, MA
 C.N.J. Wagner, University of California, Los Angeles, CA
 M.J. Weber, Lawrence Livermore Laboratory, CA

Our acknowledgements are certainly incomplete without mentioning the very splendid assistance of our students during the Conference. Ms. Barbara Brooks, Sarah Moening, and Linda Regan of our secretarial staff were all superb before, during, and after the Conference. However, nobody is more deserving of our praise and our deep gratitude for the success of every phase of the Conference than our departmental administrator, Lucia Rodriguez.

J.D. Mackenzie
 J.R. Varner
 (Conference Co-Chairmen)

CON

Part I. Str

C.N.J. Wag

F.L. Gal
RamanN. Tak
silicaD.J. L
sodaR. Brook
aspectD. Be
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structR.N. So
diffuP.J. F
A

D.R. U

P. T
AY. Band
analysiK. Takah
Fe₂O₃

J.F. Shack

CONTENTS

Part I. Structure

C.N.J. Wagner, Diffraction analysis of metallic, semiconducting and inorganic glasses	3
J.E. Galeener, J.C. Mikkelsen, Jr., A.C. Wright, R.N. Sinclair, J.A.E. Desa and J. Wong, Raman and inelastic neutron scattering by vitreous $ZnCl_2$	23
N. Takasagawa, Infrared absorption spectra and structure of fluorine-containing alkali silicate glasses	35
D.J. Lam, A.P. Paulikas and B.W. Veal, X-ray photoemission spectroscopy studies of soda aluminosilicate glasses	41
R. Brückner, H.-U. Chun, H. Goretzki and M. Sammet, XPS measurements and structural aspects of silicate and phosphate glasses	49
D. Beeman, R. Lynds and M.R. Anderson, Structural and vibrational properties of a model of vitreous As_2O_3	61
A.C. Wright, G.A.N. Connell and J.W. Allen, Amorphography and the modelling of amorphous solid structures by geometric transformations	69
G.H. Doherty, R. Dandolotti and H. Bille, A topological-dynamical model of amorphicity	87
D.F.R. Mildner and A.C. Wright, Neutron elastic diffraction and its potential use in structural studies of amorphous solids	97
R.N. Sinclair, J.A.E. Desa, G. Etherington, P.A.V. Johnson and A.C. Wright, Neutron diffraction studies of amorphous solid	107
P.J. Flory, Molecular morphology in amorphous and glassy polymers	117
D.R. Uhlmann, Polymer glasses and oxide glasses	119
P. Taylor and D.G. Owen, Liquid Immiscibility in complex borosilicate glasses	143
Y. Bando, S. Iijima, Y. Kawamoto and M. Tomozawa, Application of STEM to elemental analysis in glass	151
K. Takahashi, T. Yoshino, K. Oda and F. Kanamura, Crystallization of amorphous $BaO-Fe_2O_3$ prepared by the method without melting	157
J.F. Shackelford, The potential of structural analysis from gas transport studies	165

H.D. Schroder, Properties of redox ions in glasses: An interdisciplinary perspective	175
--	-----

S.M. Rekhson, Linear and non-linear viscoelasticity of glass	185
--	-----

Part II Optical and electrical properties

M.J. Weber, Glass for neodymium fusion lasers	189
---	-----

R.D. Maurer, Glass research for optical waveguides	197
--	-----

R.J. Araujo, Statistical mechanical model of boron coordination	209
---	-----

S. Morimoto and M. Mishima, Effect of composition on darkening and fading characteristics of silver halide photochromic glass	231
---	-----

J.R. Gannon, Optical fibre materials for operating wavelengths longer than 2 μm	239
--	-----

E.T. Stone and B.K. Tarnival, Loss reduction in optical fibers	247
--	-----

J.A. Wosacki, M.N. Colburn, S.N. Alam and J.R. Varner, Low cycle fatigue behavior of metal-coated silica fibers	261
---	-----

Y. Asahara and T. Izumitani, The properties of gradient index antireflection layer on the phase separable glass	269
---	-----

H. Kawazoe, Coordination number and chemical shift in K_2O emission of Mg^{2+} in oxide glasses	281
--	-----

D.L. Griscom, Ferromagnetic resonance of fine grained precipitates in glass: A thumbnail test	287
---	-----

D.F. Beattie, K.P. Landolt, H.L. Tuller and D.R. Uhlmann, Fast Li^+ ion conduction in crystalline glasses	297
--	-----

K.A. Weeks, R.H. Mendenhall and D.E. Kinser, The effects of OH on UV optical absorption of reduced GeO_2 glass	307
---	-----

Part III Amorphous semiconductors and electronic properties

D. Adler, Electronic structure of amorphous semiconductor	317
---	-----

S.R. Oshinsky, The chemistry of glassy materials and their relevance to energy conversion	337
---	-----

K.S. Liang, S.P. Cramer, D.C. Johnston, C.H. Chang, A.J. Jacobson, J.P. deNeufville and R.R. Chianelli, Amorphous MoSi_3 and WSi_3	347
--	-----

C.H. Chuny and J.D. Mackenzie, Electrical properties of binary semiconducting oxide glasses containing 55 mole % V_2O_5	357
---	-----

J.O. Isard, I.

J. Roberts, I.

T. Szostak, I.
in Vol. 1

Part IV, I.

S. Sakka, I.

K. Nassau, I.

R.L. Loch, I.

A. Kinoshita, I.

C.M. Butler, I.

T. Minami, I.
super

S.P. Mackenzie, I.

R. Jabra, J.E.
hot presI. Vinogradov, I.
telling, I.J.W. Allen, I.
entropyA. Boudreau, I.
strong

Part V, G.

I. E. E. E.

Y. C. C. C.
C. C. C.A. M. M. M.
M. M. M.
C. C. C.

P. J. M. M.

J.O. Isard, The application of polaron theory to oxide glasses	371
J. Robertson, Electronic structure of lead glasses and resonant covalence in glasses	381
T. Szorényi, I. Wojnárovits and L. Hevesi, Correlation between structure and properties in vanadium phosphate glasses and amorphous $V_2O_5-x/10 < x < 1$ /films	393

Part IV. Less common glasses

S. Sakka and K. Kamiya, Glasses from metal alcoholates	403
K. Nassau, Rapidly quenched glasses	423
R.E. Loehman, Oxynitride glasses	433
A. Kinoshita, Characterization of glass transition in α -As ₂ Se ₃ by heat of vaporization	447
C.M. Baldwin and J.D. Mackenzie, Ionic transport in the BeI ₂ -CsF glass system	455
T. Minami, K. Imazawa and M. Tanaka, Formation region and characterization of superionic conducting glasses in the systems AgI-Ag ₂ O-M _x O _y	469
S.P. Mukherjee, Sol-gel processes in glass science and technology	477
R. Jabra, J. Phalippou and J. Zarzycki, Synthesis of binary glass-forming oxide glasses by hot-pressing of gels	489
I. Vincze and F. van der Woude, Correlation between amorphous and metastable crystalline alloys	499
J.W. Allen, A.C. Wright and G.A.N. Connell, Hybridization, short range order, and entropy in metallic glass formation	509
A. Bishay, M. Farag, M. Nassrallah, S. El Nahawi and S.A. Saleh, Some properties and structure of iron-containing glasses and glass-metal composites	525

Part V. Glass surfaces and chemical durability

H. Franz, Durability and corrosion of silicate glass surfaces	529
Y. Oka and M. Tomozawa, Effect of alkaline earth ion as an inhibitor to alkaline attack on silica glass	535
A. Makishima, H. Ohashi, M. Wakakuwa, K. Kotani and T. Shimohara, Alkaline durabilities and structures of amorphous aluminosilicates containing ZrO ₂ prepared by the chemical polymerization of metal alkoxides	545
P.J. Melling and A.R. Allnatt, Modelling of leaching and corrosion of glass	553

H.J. Franck, G.H. Frischat and H. Knodler, Reactions between aqueous solutions and glass surfaces	561
S. Adachi, E. Miyado and T. Izumitani, Chemical durability of optical glass	569
L. Rongved, C.R. Kurjian and E.T. Geyling, Mechanical tempering of optical fibers	579
L. Schaar, Themes for glass research in the field of hollow ware production	585
V.V. Moiseev, Ion exchange and constitution of glass	589
M. Spitzer-Aronson, A new method for the study of flat glasses accurate microstructure implications of trace elements variation on the structure of glasses	601
S.K. Sharma, B. Simons and J.F. Mammone, Relationship between density, refractive index and structure of B_2O_3 glasses at low and high pressures	607
K. Katsuki, K. Shibaoka, S. Onishi and T. Miwa, Laminated sheet composed of thin glass and plastic sheets	614
B.S. Naidu, A.K. Sharma, D.V.K. Sastry, Y. Syamalamba and P. Jayarama Reddy, Physical investigations on amorphous films of some semiconducting compounds	637
<i>Author index</i>	653
<i>Subject index</i>	659

SECTION
Structure

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DATE
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5 - 8 - 1

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